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Determination of Cloud Altitude from a Satellite

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The successful flight of Tiros I has stimulated the interest of geophysicists and meteorologists in cloud formations.

It is very difficult, if not impossible, however, to judge the type of cloud in a picture taken by a satellite. Such judgment would be greatly enhanced if the altitude of the cloud were known. A method of measuring altitudes of clouds from a satellite is proposed in this letter.

The method is based on infrared asborponti by CO_2 in the air layer above clouds. The amotun of air above the upper boundary of a cloud is a rapidly changing function of the altitude of the cloud. Sunlight scattered by the cloud traverses the air layer above the cloud twice before it can be detected from a satellite. The absorption by CO_2 is best measured by comparing the intensity of reflected solar radiation in a CO_2 absorption band with the intensity in an atmospheric window nearby. Since CO_2 is uniformly distributed in the atmosphere, the absorption in the CO_2 band is a measure of the amount of atmosphere above the clouds and hence of their altitude.

A similar measurement in a water vapor absorption band will yield the total amount of water vapor above the cloud, which is another parameter of meteorological interest. By the same method *Strong, Ross, and Moore* [1960] were able to detect water vapor on Venus with a balloon-borne instrument.

Simultaneously with the CO_2 and H_2O absorption, the cloud-top temperature should be registered. The same field of view should be used for all three measurements.

Preliminary investigations indicate the following wavelength bands to be best suited for the experiments:

First reference window	1.5– 1.7 μ
Water vapor absorption band	1.8– 1.9 μ
CO_2 absorption band	2 – 2.1 μ
Second reference window	2.1– 2.2 μ
Thermal emission of cloud	10 –12 μ

The simplest equipment for this experiment is a set of fixed detectors, mounted on a stabilized platform, which measure the intensities at the subsatellite point within the five spectral ranges mentioned above.

Corrections for the local solar elevation angle and wavelength dependence of back scattering of clouds must be applied. The experiment is well suited to a local noon orbit. It is restricted to the sunlit side of the earth and to moderate angles of solar incidence, perhaps to 45° or 60°.

The value of the experiment is greatly enhanced by cloud-cover pictures taken simultaneously.

REFERENCES

Strong, John, M. D. Ross, and C. B. Moore, Some observations of the atmospheres of Venus and the earth during the Strato Lab IV balloon flight, American Geophysical Union Meeting, Washington, D. C., April, 1960.

Stroud, W. G., Initial results of the Tiros I meteorological satellite, *J. Geophys. Research, 65*, 1643–1644, 1960.

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